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Art. II.—*The Resistance of Some Australian Timbers to Decay by Mine Fungi.*

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Introduction

Very little mycological work has been done in Australia on the decay of mine timbers. This paper describes some investigation carried out on Australian mine fungi, with particular reference to their ability to cause decay of Australian hardwood timbers. The fungi discussed were all obtained in pure culture from decayed mine timber or from fruiting bodies present in a lead-zinc mine at Broken Hill. An attempt was made to discover which fungi were responsible for the main decay of timbers in the mine and which were the most prevalent.

The Fungi

Coniophora cerebella Pers, *Polyporus zonalis* Berk, *Trametes serialis* Fr., *Poria xantha,* Lind. non Fr., and *Merulius pinastri* Fr. are the wood-destroying fungi which were isolated and identified. Others were isolated in culture and found to cause considerable decay but have not so far been positively identified. Throughout this paper all colours written in italics are taken from Ridgway's Colour Standards and Colour Nomenclature (18).

Coniophora cerebella was isolated from decayed mine timber more frequently than any other wood-destroying fungus. It thrives in damp localities and is found commonly in mines and cellars throughout the world. This fungus gives rise to a dark-brown rot which can spread rapidly under moist conditions and its presence must be regarded very seriously. Hard-woods and softwoods are attacked indiscriminately and even the densest hardwoods are not immune to decay by this fungus. Its typical olive-brown warted sheets of fructification and black twine-like strands were seen spreading copiously in all the damp parts of the mine. Basidiospores from these fructifications measured from 7–11 × 5–9μ, with an average of 9·1 × 6·7μ. This is the first record of the undoubted occurrence of *C. cerebella* in Australia. Scott (20) reported considerable trouble with jarrah (*E. marginata*) and Red Gum (*E. rostrata*) paving blocks and considered that the decay was probably due to this fungus.

Polyporus zonalis was found to be the cause of serious white-pocket rot in the hardwoods, particularly in very moist situations. In America this fungus is known to give rise to a white-pocket rot of hardwoods, including Oak, and is widespread in the tropics, causing decay in tea and rubber plants. Brown (4) reports that *Polyporus rugulosus,* which is synonymous with *P. zonalis,* is present in very moist parts of the mines in South Africa. Dr. T. W. Bowen was good enough to forward a specimen of one of these fruiting bodies and it agreed in all details with the Australian form. He stated in a private communication that he had found it on mine timbers only, never above the ground, both in Southern and Northern Rhodesia and that it was undoubtedly in the copper mines of the Belgian Congo. He thought it was the most virulent wood-destroying fungus he had encountered. Cooke (10) notes that *P. zonalis* has been found on dead wood in Victoria and Queensland.

P. zonalis is able to form copious typical fruiting bodies underground and many perfect specimens were seen and collected. The tough leathery fruiting bodies have a smooth maize-yellow hymenium and narrow incurved cream edge when young. The hymenium darkens as it becomes older and when dry is *flesh-ocher* to *vinaceous-tawny* in colour, Ridgway (18) while in section the colour is lighter, from *maize-yellow* to *pinkish-buff*. The upper surface is zoned and velvety and usually pale-yellow to warm-brown in colour. Encrusted cystidia are common in the hymenium and are considered by Bose (3) to be the most characteristic feature of this fungus.

It should perhaps be pointed out here that Oregon (*Pseudotsuga taxifolia*) was formerly used almost exclusively in the mine from which the fungi were isolated. However, owing to difficulties of supply during the last war, some Australian hardwoods were substituted. Although these timbers proved more resistant to decay than the Oregon underground, it was not until very recent years that they began to replace it to any extent. This replacement has now been accelerated by the practical exclusion of imported softwoods from the Australian market. Considering the presence of so much Oregon in the mine, it was not surprising to find wood-destroying fungi which are typical softwood rotters and would not be expected under normal conditions in Australia. The most common of these is *Trametes serialis*, which was found most often attacking Oregon, but was also seen to cause a brown rot of hardwoods. *T. serialis* is well known in Britain as the most important cause of decay of imported Oregon, but this is the first time it has been recorded in Australia. In America it is responsible for considerable brown rot of softwoods in buildings and in storage. Pilat (17) has reported that this fungus is found frequently in the coal mines at Pribram in Czechoslovakia.

Many cream to chalky white fruiting bodies, ranging from small cushions to perfect bracket shapes, were seen in the mine. They became discoloured on bruising and showed tinges of brown on ageing and were thought at first to belong to *Trametes serialis*. However, pure cultures obtained from many of these were very different from *T. serialis* in culture; in fact, they resembled much more closely cultures of *Polyporus fumosus* Fr. as described by Cartwright (7). Similar cultures were obtained frequently from decayed timber showing brown rot. Until definitely identified, they will be referred to as *Trametes* species.

Poria xantha was also isolated from decayed Oregon in the mine although not as consistently as *T. serialis* and the *Trametes* sp. (A1 and D6). According to Cartwright and Findlay (8) who give a detailed account of the two fungi, *P. xantha* is the frequent cause of much decay in the woodwork of hot houses in Great Britain. It is also one of the principal fungi responsible for the decay of roofs of paper mills in Canada, but its presence has not been recorded before in Australia. The poroid fructification was found occasionally in the mine. It is resupinate and spreads as a thin sulphur yellow layer over the surface of the wood. The pores are normally small and rounded but occasionally become irregular and more elongated. The basidiospores are hyaline and allantoid and range from $3–7 \times 1{\cdot}5–2{\cdot}5\mu$, the average size being $4{\cdot}8 \times 2\mu$. The fructification is characterized by a sweet odour reminiscent of lemons. Badcock (1) noted this and recorded the scent as sweet limonene or almost lemon.

Merulius lacrymans, the dry rot fungus, was not seen or isolated from the mine timber. However, another species of *Merulius* (*M. pinastri*) was found to be very widespread on Oregon, causing considerable brown rot. It was not seen to attack any hardwood in the mine, even when this stood

in immediate contact with Oregon badly decayed by this fungus. Cartwright and Findlay (8) record *M. pinastri* as a fungus of minor importance on softwoods in Great Britain. It is not often described or mentioned as a wood-destroyer. However, Burt (5), who described the fruiting bodies in detail, stated that they were found on decaying wood and bark, usually coniferous. Brown (4) mentions a species of *Merulius* that is common in the South African mines at relatively high temperatures but does not give any description. She also notes the absence of *M. lacrymans* from the same mines.

M. pinastri forms large perfect fruiting bodies in the mine, bracket-shaped or circular, according to their position on horizontally or vertically placed timber. They are usally found in the damper part of the mine associated with widespreading fluffy mycelium, which is white at the edges, but brown in the older portions. The young fruiting bodies have a thick rolled creamy white edge surrounding the *pinard yellow* hymenium which covers little tubercles or very short teeth. The teeth lengthen as the fruiting bodies age and become *olivaceous brown* in colour. Spores are yellow-brown and oval, measuring $3–5 \times 2–3\mu$ with an average size of $4 \times 2{\cdot}5\mu$. The whole fruiting body is very soft and flabby when gathered, and the tissue of the pileus is yellow and stringy. Pure cultures were obtained from the fruiting bodies, but never from decayed timber. Growth was extremely slow in culture and, in making isolations from decayed wood, the fungus was always overwhelmed by faster growing moulds.

Several other basidiomycetes were obtained in pure culture from decayed mine timbers, but have not yet been identified. One of these, referred to subsequently as D2, causes a brown rot and appears to be almost as virulent a wood-destroyer as *Coniophora cerebella*.

Inoculation Experiments

Experimental Procedure

Experiments were carried out to determine the comparative resistance of a number of species of Australian hardwoods to decay by the mine fungi. The experimental procedure differed somewhat from the standard method of testing the decay of timbers, in which oven-dried blocks are placed under sterile conditions on a young mycelial mat of the fungus growing on malt agar in special Kolle flasks. In this type of test, the blocks are sterilized by the oven-drying alone, and not by subsequent heating in an autoclave. It is claimed that the extra heating in the moist atmosphere of the autoclave tends to soften the wood, and thus makes it less resistant to decay by wood-destroying fungi. However, in an experiment carried out to test this, the loss of weight in unautoclaved blocks of messmate placed directly on the mycelial mat of *C. cerebella* was even greater than that in the autoclaved blocks subjected to attack by the same fungus (see Table 5). The fungal mat was not grown on malt agar, but on soil to which 10 per cent. of the accelerator, recommended by Badcock (2), had been added. This accelerator is made up of 50 parts maize meal, 30 parts bone meal, 17 parts potato starch, 2 parts sucrose, and 1 part wood ash by weight. When the blocks were autoclaved, the experimental procedure was always the same and each timber was subjected to attack under similar conditions, hence the results should be strictly comparable. Kolle flasks were not available for these experiments, and the soil method of Leutritz (16) was used. This method appears preferable, as the conditions of the experiment approximate more closely to the natural condition of the mine.

Five hundred grams of oven-dry soil were placed in screw-top jars of 1 litre capacity. Water was then added and mixed thoroughly with the soil, the percentage varying with the experimental series, usually 25 or 30 per cent. Two blocks of the timber under test were imbedded in the soil in each jar, leaving one corner projecting. (For some experiments larger jars had to be used, with 800 grams of soil and four blocks instead of two.) The lids were placed loosely on the jars, which were then sterilized for 30 minutes on three successive days in an autoclave at one and a half atmospheres pressure. After the final sterilization, the projecting corner of the blocks was inoculated with the appropriate fungus from a young culture on malt agar. The caps were then screwed down tightly and the jars kept for six months in an incubator room at approximately 25°C.

The experimental blocks were taken from sound seasoned truewood and were of uniform size, $2 \times 1 \times 1$ inches, with the length running across the grain of the timber. They were oven-dried at 102–104°C. for four days, weighed and placed oven-dry in the jars. In the standard test, a period of eighteen hours is recommended for oven-drying. It was found that this was not long enough for the complete drying-out of blocks of the heavier timbers, which lost considerably in weight after the first day. Since any timber will go on losing weight in very minute quantities over an extended period of time, it was decided to take the oven-dry weight after four days, by which time the weight was approximately constant. At the end of the experiment, the blocks were removed from the jar, freed carefully from adhering soil and mycelium, and weighed immediately. They were then oven-dried again. Appreciable weight was still being lost by the fourth day. By the eighth day, loss in weight was negligible, and therefore oven-drying was carried out over a period of eight days instead of four at the end of the experiment. The percentage loss in oven-dry weight, based on the original oven-dry weight, was taken as a measure of the amount of decay. Controls were run with each series, the procedure for these differing only in the absence of any inoculation. The final oven-dry weights of the control blocks served as a check against any decay by intruding soil fungi.

The Test Fungi.

As many different species and isolations of wood-destroying fungi from the mine as possible were used in the inoculation tests in order to determine the most virulent forms, those still unidentified are designated by numbers and letters alone. The following list sets out the forms used:—

Coniophora cerebella—B2 and B11.
Merulius pinastri—M16.
Polyporus zonalis—M3.
Trametes serialis—B9.
Trametes sp.—A1 and D6.
Poria xantha—A8 and A9.
Polystictus versicolor—P2.
Unknown—A3.
Unknown—B9A.
Unknown—D2.

Polystictus versicolor has not been found in the mine, but is included in standard laboratory experiments for the determination of resistance to decay of hardwoods on account of its virulence as a wood-destroyer. It is a white rot fungus which is very widespread in Australia, and which is found in mines all over the world. The culture used here was obtained from a fruiting body found on a rotten log in Victoria.

Coniophora cerebella proved to be the most virulent of the fungi in attacking the hardwoods, but the unknown D2 also showed itself to be a very potent wood-destroyer, causing definite decay in the more resistant hardwoods. The *Trametes* sp. (cultures A1 and D6) and the unknown A3 caused some decay of the denser hardwoods and very considerable decay of the lighter timbers tested.

Contrary to expectations, the decay caused by *Polyporus zonalis* was insignificant in most cases. This fungus was always seen in extremely moist situations in the mine, and it is thought that the moisture content of the experimental blocks was not high enough to permit this moisture-loving fungus to become really active.

Great difficulties were experienced in inoculating timber with *Merulius pinastri,* and although many attempts were made, success was reached with only a few of the timbers tested. In cases where the fungus did grow, however, it attacked the softwoods readily and proved to be a surprisingly virulent destroyer of hardwoods, in contrast to the related species, *M. lacrymans.* It is known from former experience that *M. lacrymans,* although so potent a wood-destroyer, is extremely sensitive in culture. It will stand little disturbance with an inoculating needle, and is easily killed by slight increases of temperature above the low optimum temperature. This sensibility in culture, combined with its extremely slow growth, explains the difficulty experienced in inoculating timber with this fungus.

Poria xantha and *Trametes serialis,* both typical softwood rotters, were unable to produce decay in the denser hardwoods, but caused definite rot of the lighter ones.

The Test Timbers.

The principal hardwoods used in the mine to replace the softwood (oregon) are blackbutt, messmate, and river red gum, but owing to practical difficulties of supply, many other timbers occur in lesser quantities. Samples sent down to Melbourne for specific determination included red bloodwood, mountain grey gum, tallow-wood, forest red gum, red mahogany, spotted gum, and brush box, in addition to the three species mentioned above. (The common names of timbers used in this paper are those listed as standard common names in "The Nomenclature of Australian Timbers" (21).)

Little data based on laboratory experiments are available on the durability of Australian timbers. Cummins and Dadswell (11), in discussing the main pole timbers of Australia, stated that the figures for pole life were based largely on opinions or general results, and that no detailed records were available. They placed the timbers in three classes, according to their durability. In selecting timbers to be used for tests against the mine fungi, types were chosen from these three classes, in addition to the three main hardwood timbers of the mine. Those selected are as follows:—

Callitris glauca—Cypress pine.
Eucalyptus capitellata—Brown stringy bark.
E. maculata—Spotted gum.
E. microcorys—Tallow-wood.
E. obliqua—Messmate.
E. pilularis—Blackbutt.
E. regnans—Mountain ash.
E. rostrata—River red gum.
E. saligna—Sydney blue gum.
Pseudotsuga taxifolia—Oregon.

Cypress pine was classified by Cummins and Dadswell as " very durable," tallow-wood and river red gum as " durable," and spotted gum, messmate, and blackbutt as " less durable." Oregon was included in the tests for comparison with the hardwoods on account of its former widespread use in the mine.

Two series of experiments were run for each timber, one in which the initial moisture content of the soil was 25 per cent., the other 30 per cent. All experiments ran for a period of six months.

Eight blocks of each timber were subjected to attack by each fungus in each series. The percentage loss in oven-dry weight was determined, and the average for the eight blocks taken as the percentage loss in weight for a particular timber when attacked by the fungus in question.

In experiments such as these, the timbers are exposed to the wood-destroying fungi under very favourable conditions for attack. Thus the rate of decay is probably considerably accelerated. However, the comparative resistance to decay can be determined in this way in a relatively short time. Under the more natural and fluctuating conditions in the mine, it is likely that decay would take place more slowly. Valuable information on this point would be obtained by carrying out tests in the mine itself with samples of the different timbers.

It should be pointed out here that in each case timber from one source only was tested. Timbers of one particular species may vary considerably in density and toughness, and in its resistance to decay. In order to obtain really conclusive results in tests of this nature, samples of each timber should be taken from five or six different localities. However, the extensive facilities for carrying out such varied and widespread investigations were not available. The results obtained at least give an indication of the behaviour that can be expected from the different timbers when placed under conditions where decay is likely to occur. Further work with timbers from varied sources is in hand.

The attack by *Coniophora cerebella* (B11) on all timbers has been chosen as a typical example. Complete figures are given for timbers of a high, medium, and low resistance when exposed to this fungus (see Table 4 and Graph 1). Graphs 2 and 3 show the comparative effect of six typical fungi on all the timbers tested.

Moisture Content of the Soil and Blocks.

The moisture content of the timber varies tremendously in different parts of the mine. In the vicinity of those parts where ore is actually being removed and is replaced by sand which is flooded in with water, the timber is actually waterlogged. In other localities, particularly in the main stopes away from active removal of the ore, the timber is much drier. Decay is influenced largely by the moisture content of the timber. Timber with a moisture content of less than about 20 per cent. will not decay to any extent, because there is not sufficient moisture for the growth of the fungus. Timber which is completely waterlogged will not decay because there is insufficient oxygen for the growth of the fungus. Between the two extremes, decay is possible. The optimum moisture content of the timber for decay depends on the species of the wood-destroying fungus, but is said to vary from 30 per cent. to 60 per cent. of the oven-dry weight of the timber. For instance, *Merulius lacrymans* is able to attack timber with a very low moisture content, whilst *Coniophora cerebella* requires a much higher moisture content.

Difficulty was experienced in ascertaining optimum moisture conditions for the fungi under test, and in obtaining similar moisture conditions in the blocks in each timber. Different timbers, or even different specimens of the same timber, will take up varying amounts of moisture under identical conditions. Cartwright (6) in discussing the decay of sitka spruce by *Trametes serialis* noted the practical impossibility of obtaining samples of wood, which will, under the same conditions, take up equal amounts of water. This makes it doubtful whether extreme accuracy in controlling these factors would not be wasted.

In the early stages of the work, an experiment was carried out with the purpose of determining the most suitable percentage of moisture for the soil in the jars. The non-resistant timber, mountain ash, was exposed to attack by three different isolations of the potent wood-destroyer *Coniophora cerebella* at different soil moisture contents. The cultures used were B2 and B11, already mentioned as having been isolated from decayed oregon and B3, which was obtained from brown rot in messmate. Four series were carried out with each fungal culture; in the first series the moisture content of the soil was 20 per cent., in the second 25 per cent., in the third 30 per cent., and in the fourth 35 per cent. The results are set out in Table 1.

Table 1.—*Eucalyptus regnans*—Exposed to Three Different Strains of *Coniophora cerebella* for Six Months; with Varying Moisture Contents of the Soil.

Percentage Moisture Content of—		Percentage Loss in Weight Due to Decay by—		
Soil.	Blocks.	B. 2.	B. 3.	B. 11.
20	50·8	48·1	48·3	56·8
25	63·5	41·2	52·0	64·6
30	82·7	45·0	48·0	54·1
35	98·9	33·5	31·5	36·8

The figures in the second column, referring to the percentage moisture contents of the blocks, were obtained by taking the average moisture content of the controls for each series at the end of the experiment. This is seen to rise with increase in moisture content of the soil and reaches nearly 100 per cent. in the 35 per cent. series. The amount of decay was considerable in every case, but did not vary greatly in the first three series. In the fourth, however, the amount of decay was significantly lower for each isolation, and the statistical analysis of the results showed the effect of moisture content to be highly significant. The moisture content in these blocks was obviously above the optimum even for the moisture-loving *C. cerebella* (see Graph 1).

It was decided, in view of these results, to use the two series with medium moisture contents of the soil for all future experiments. In the first series, the amount of water added to the soil was 25 per cent. of its oven-dry weight. In the second series 30 per cent. was added. The percentage of moisture taken up from the soil by the blocks varied considerably and could not be controlled accurately. The lighter timbers, such as mountain ash, messmate, brown stringy bark, oregon, and cypress pine took up much more moisture than did the denser timbers blackbutt, river red gum, spotted gum, and tallow-wood. An indication of the moisture content of the blocks during the experiment was obtained from the moisture content of the controls at the end of the experiment. Figures for these are

given in Tables 2–5, together with the loss in weight due to decay in the inoculated blocks. Extra control jars were set up in one experiment, and these were opened after different periods of time, from one to six months, and the blocks used for moisture content determinations. From these it was seen that the amount of moisture in the blocks was approximately the same at the end of the experiment as during the first and following months. This was not the case, however, in the inoculated blocks. When decay took place, the timber took up more moisture and became spongy and less dense. Thus as a rule, the greater the decay, the higher was the moisture content.

A comparison of Graphs 2 and 3 will show the difference in the amount of decay caused by several of the fungi in the two series of soil moisture contents. In the majority of cases, the amount of decay was somewhat greater in the blocks of the series with soil at 25 per cent. moisture content. This even held for the attack by the moisture-loving *Coniophora cerebella,* except with the timber Sydney blue gum where considerably more decay was present in the series with 30 per cent. soil moisture content than with the 25 per cent. series.

The percentage of moisture in the blocks seemed to be suitable for decay by all fungi except *Polyporous zonalis.* The amount of decay caused by this fungus in both series of experiments was never great, and it is thought that this was probably due to an insufficiency of moisture. *P. zonalis,* unlike other mine fungi, caused extensive decay only in those parts of the mine where particularly moist conditions prevailed, and where the timber was dripping with moisture. It would, therefore, be desirable to test cultures of this fungus on blocks in soil with a considerably higher moisture content than that used in the tests already described. Preliminary tests have indicated that considerably more rot would be caused by *P. zonalis* at a soil moisture content of 45 per cent.

No statistical analysis of the difference in resistance of different species of timber was carried out, since each species was represented by material from only one source. However, the results obtained indicated that the species examined fell into three groups of resistance, namely, high, medium, and low resistance, which appeared very well demarcated. Since the different species differed in the variability of the loss in weight as well as in the mean loss obtained with each fungus, each was analysed separately and each fungus in each moisture content regarded as a different treatment. Significant differences of treatment means were worked out for each species of timber, the significant differences being based on the average variance of treatment means for the species. These figures are included in Tables 2 and 3. Thus, the significant difference at the 10 per cent. level for mountain ash is 12·41—this means that if the difference between the mean losses caused by any two fungi attacking this timber is higher than 12·41, there is a significant difference in the virulence of those fungi towards it. For example, *C. cerebella* can be expected to cause more rot of mountain ash than can *Poria xantha,* but the latter fungus cannot be expected to cause more rot than the unknown fungus A3.

Experimental Results.

Owing to the bulk of the tables, complete results for all experiments are not included, a summary of the results is given instead, in Tables 2 and 3. Complete figures for the attack by *Coniophora cerebella* on a timber from each of the three groups of resistance, high, medium, and low, are given in Table 4. Graphs 2 and 3 show the comparative effect of six typical fungi on all the timbers tested.

TABLE 2.—SUMMARY OF THE MEAN LOSS OF WEIGHT CAUSED BY THE TEST FUNGI IN EACH TIMBER. MOISTURE CONTENT OF THE SOIL 25 PER CENT.

Fungus.	Loss in weight per cent., based on loss of oven-dry weight. (Mean value of 8 blocks.)									
	Mountain Ash.	Messmate.	Brown Stringy Bark.	Sydney Blue Gum.	Blackbutt.	Spotted Gum.	River Red Gum.	Tallow-wood.	Cypress Pine.	Oregon.
Coniophora cerebella B2 ..	48·5	32·0	22·9	12·7	7·2	14·1	17·3	6·8	6·8	63·3
Coniophora cerebella B11 ..	64·6	28·1	21·9	16·1	17·5	16·5	12·5	11·0	5·7	60·8
Merulius pinastri M16 ..	..	..	40·1	1·5	..	..	8·4	..	17·4	41·4
Polyporus zonalis M3	..	5·6	7·3	1·9	2·3	..	2·0	2·2	..	12·6
Trametes serialis B9	40·9	11·5	3·7	5·5	2·8	7·2	2·2	2·5	3·1	63·9
Trametes Sp. A1	..	17·8	33·1	9·7	8·6	4·6	13·1	4·0	2·1	49·5
Trametes Sp. D6	..	45·1	12·4	12·0	4·7	10·5	2·6	6·7	19·7	55·6
Poria xantha A8	..	..	2·4	2·8	2·2	2·8	1·6	..	4·8	38·5
Poria xantha A9	26·5	18·0	2·8	1·4	2·7	2·3	1·6	..	23·6	45·2
Polystictus versicolor P2 ..	..	..	..	..	2·9	4·8	1·6	1·9	8·1	..
Unknown A3	22·7	25·7	7·8	10·0	9·3	4·2	12·9	4·9	..	28·6
Unknown B9A	49·2	9·6	3·0	2·4	2·7	1·0	2·0	2·0	9·0	50·3
Unknown D2	..	..	..	..	..	9·8	12·1	13·4	38·1	..
Controls	1·4	1·0	2·2	1·2	1·7	0·7	1·2	1·8	2·3	4·2
Significant difference of treatment means at 1 per cent. level ..	12·41	12·18	8·15	4·09	3·06	3·10	5·36	2·71	16·76	11·90
Significant difference of treatment means at 5 per cent. level ..	9·17	8·98	6·09	3·08	2·24	2·33	4·04	2·06	12·33	8·95
Average moisture content percentage of controls	76·2	65·6	55·2	46·5	45·4	28·8	34·0	29·4	40·9	36·7
Mean of treatments (loss percentage) for all fungi used	42·1	21·5	14·3	6·9	5·7	7·1	6·9	5·5	12·1	46·3

TABLE 3.—SUMMARY OF THE MEAN LOSS OF WEIGHT CAUSED BY THE TEST FUNGI IN EACH TIMBER. MOISTURE CONTENT OF THE SOIL 30 PER CENT.

Fungus.	Loss in weight per cent., based on loss of oven-dry weight. (Mean value of 8 blocks.)									
	Mountain Ash.	Messmate.	Brown Stringy Bark.	Sydney Blue Gum.	Blackbutt.	Spotted Gum.	River Red Gum.	Tallow-wood.	Cypress Pine.	Oregon.
Coniophora cerebella B2 ..	44·0	23·4	..	29·3	7·0	8·1	6·7	4·9	7·2	43·4
Coniophora cerebella B11 ..	47·6	25·2	18·7	32·1	13·9	8·9	12·9	7·1	5·1	39·4
Merulius pinastri M16 ..	..	..	23·2	..	..	..	..	3·4	19·6	33·1
Polyporus zonalis M3	..	..	14·5	..	..	..	1·9	2·5	..	13·1
Trametes serialis B9	..	24·1	7·0	1·8	3·9	4·1	2·3	2·1	8·8	56·0
Trametes Sp. A1	..	18·3	..	4·0	7·1	2·8	2·7	5·8	6·6	29·6
Trametes Sp. D6	..	..	16·6	..	..	..	4·8	5·7	19·6	56·8
Poria xantha A8	..	19·4	..	1·5	1·9	1·1	1·6	..	24·4	34·7
Poria xantha A9	..	19·9	2·9	1·5	2·2	1·0	1·6	2·1	10·2	31·3
Polystictus versicolor P2 ..	..	..	..	..	..	6·5	1·7	2·3	3·7	..
Unknown A3	..	21·2	..	4·6	4·1	5·2	4·1	3·0	2·7	24·1
Unknown B9A	..	14·2	..	2·0	2·0	1·4	1·6	2·1	2·8	..
Unknown D2	..	..	..	..	..	7·6	9·4	9·8	3·9	..
Controls	0·6	1·4	1·7	1·3	1·5	1·3	1·4	2·3	3·4	3·8
Significant difference of treatment means at 1 per cent. level ..	12·41	12·18	8·15	4·09	3·06	3·10	5·36	2·74	16·76	11·90
Significant difference of treatment means at 5 per cent. level ..	9·17	8·98	6·09	3·08	2·24	2·33	4·04	2·06	12·33	8·95
Average moisture content percentage of controls	82·7	69·2	78·8	41·6	58·7	37·5	33·6	18·4	92·4	77·9
Mean of treatments (loss percentage) for all fungi used	45·8	20·7	13·8	9·6	5·2	4·7	4·3	4·2	9·6	36·2

TABLE 4.—EFFECT OF *Coniophora cerebella* B11 ON TEST TIMBERS AT 25 PER CENT. MOISTURE CONTENT OF SOIL.

Timber.	No. of Block.	Original Oven-dry Weight.	Weight on Removal from Jar.	Final Oven-dry Weight.	Loss of Weight in Grams.	Loss of Weight Per Cent.	Final Moisture Content Per Cent.	Average Loss of Weight Per Cent.	Average Moisture Content Per Cent.
Mountain Ash ..	98	24·51	20·47	9·32	15·19	62·0	119·6	64·6	99·1
	130	23·83	17·55	8·63	15·20	63·8	103·4		
	73	24·42	18·38	9·95	14·47	59·3	84·7		
	129	22·36	13·92	7·58	14·78	66·1	83·6		
	97	24·48	14·17	7·15	15·33	68·2	98·2		
	108	24·77	16·21	7·90	16·87	68·1	105·2		
Controls* ..	7	22·81	40·39	22·28	0·53	2·4	81·3	1·4	76·2
	46	26·77	42·61	26·61	0·16	0·6	60·1		
	9	23·35	43·68	23·06	0·29	1·3	89·4		
	58	24·37	42·79	24·12	0·25	1·1	77·4		
	8	22·79	43·04	22·36	0·43	1·9	92·5		
	54	22·25	45·97	25·00	0·25	1·0	83·9		
	19	23·72	38·02	23·38	0·34	1·4	62·6		
	23	23·40	37·42	23·09	0·31	1·3	62·5		
Messmate ..	169	21·66	36·26	15·47	6·19	28·6	134·4	28·1	133·9
	170	21·61	36·32	15·38	6·23	28·8	136·2		
	171	21·54	35·87	15·35	6·19	28·7	133·7		
	172	21·72	37·39	16·41	5·31	24·4	127·8		
	173	21·55	35·38	15·41	6·14	28·5	129·6		
	174	21·72	36·14	15·30	6·42	29·6	136·2		
	175	21·78	36·80	15·70	6·08	27·9	134·4		
	176	21·76	37·17	15·54	6·22	28·6	138·5		
Controls ..	185	22·23	37·37	21·95	0·28	1·3	70·3	1·0	65·6
	186	22·35	36·82	22·13	0·22	1·0	66·4		
	187	22·65	38·16	22·43	0·21	0·9	70·1		
	188	22·47	37·41	22·24	0·23	1·0	68·2		
	189	22·84	36·32	22·69	0·15	0·7	60·1		
	190	23·22	35·44	23·10	0·12	0·5	53·5		
	191	22·91	38·30	22·66	0·25	1·1	69·0		
	192	22·94	37·90	22·67	0·27	1·2	67·2		
Brown Stringybark	49	18·75	25·88	16·15	2·60	13·9	60·2	21·9	64·9
	50	18·02	22·97	14·10	3·92	21·8	62·9		
	51	18·24	23·52	14·42	3·82	20·9	63·1		
	52	18·35	23·33	14·53	3·82	20·8	60·6		
	53	17·87	23·22	13·93	3·94	22·0	66·7		
	54	17·78	21·74	13·10	4·68	26·3	66·0		
	55	17·65	22·72	13·33	4·32	24·5	70·4		
	56	17·63	22·28	13·17	4·46	25·3	69·2		
Controls ..	41	17·88	27·56	17·50	0·38	2·1	57·5	2·2	55·2
	42	18·07	27·77	17·64	0·43	2·4	57·4		
	43	18·12	27·70	17·72	0·40	2·2	56·3		
	44	18·31	27·39	17·87	0·44	2·4	53·3		
	45	18·36	28·20	17·97	0·39	2·0	56·9		
	46	18·61	28·48	18·20	0·41	2·2	56·5		
	47	18·77	28·07	18·38	0·39	2·1	52·7		
	48	18·75	27·64	18·34	0·41	2·2	50·7		
Blackbutt ..	157	25·31	35·40	20·31	5·00	20·0	74·3	17·5	62·5
	158	25·20	32·87	19·24	5·96	23·7	70·8		
	159	25·21	37·32	21·61	3·60	14·3	72·7		
	160	25·24	34·50	20·40	4·84	19·2	69·1		
	161	25·28	35·06	22·59	2·69	10·6	55·2		
	162	25·49	34·77	22·20	3·29	12·9	56·6		
	163	25·58	33·61	21·87	3·71	14·5	53·7		
	164	25·65	28·56	19·40	6·25	24·4	47·2		
Controls ..	189	26·28	37·99	25·86	0·42	1·6	46·9	1·7	45·4
	190	26·41	38·38	25·98	0·43	1·6	47·7		
	191	26·57	38·08	26·18	0·39	1·5	45·5		
	192	26·22	38·91	25·75	0·47	1·8	51·1		
	193	26·07	36·91	25·61	0·46	1·8	44·1		
	194	26·19	36·98	25·77	0·42	1·6	43·5		
	195	26·14	37·33	25·61	0·53	2·0	45·8		
	196	26·29	35·83	25·88	0·41	1·6	38·4		

* These jars served as controls for all fungi.

TABLE 5.—EFFECT OF *Coniophora cerebella* ON UNAUTOCLAVED BLOCKS OF MESSMATE.

Fungus.	No. of Block.	Original Oven-dry Weight.	Weight on Removal from Jar.	Final Oven-dry Weight.	Loss of Weight in Grams.	Loss of Weight Per Cent.	Final Moisture Content Per Cent.	Average Loss of Weight Per Cent.	Average Moisture Content Per Cent.
Coniophora cerebella B11	99	22·88	32·36	15·02	7·86	34·4	115·4	34·2	112·2
	105	22·89	35·55	16·64	6·25	27·3	113·6		
	95	22·98	33·40	15·71	7·27	31·6	112·6		
	98	22·78	30·42	14·26	8·52	37·4	113·3		
	91	23·01	24·03	11·74	11·27	49·0	104·7		
	94	22·83	26·77	13·04	9·79	42·9	105·3		
	97	22·69	39·69	19·38	3·31	14·6	104·8		
	100	22·61	32·76	14·40	8·21	36·3	127·5		
Controls ..	5	22·45	28·38	22·38	0·07	0·3	26·8	0·6	32·5
	6	22·62	28·56	22·53	0·09	0·4	26·8		
	7	22·40	28·32	22·30	0·10	0·4	27·0		
	8	22·21	28·08	22·11	0·10	0·5	27·0		
	90	23·27	32·10	23·07	0·20	0·9	39·1		
	92	22·91	32·12	22·74	0·17	0·7	41·2		
	93	23·37	30·57	23·24	0·13	0·6	31·5		
	96	22·74	31·82	22·60	0·14	0·6	40·8		

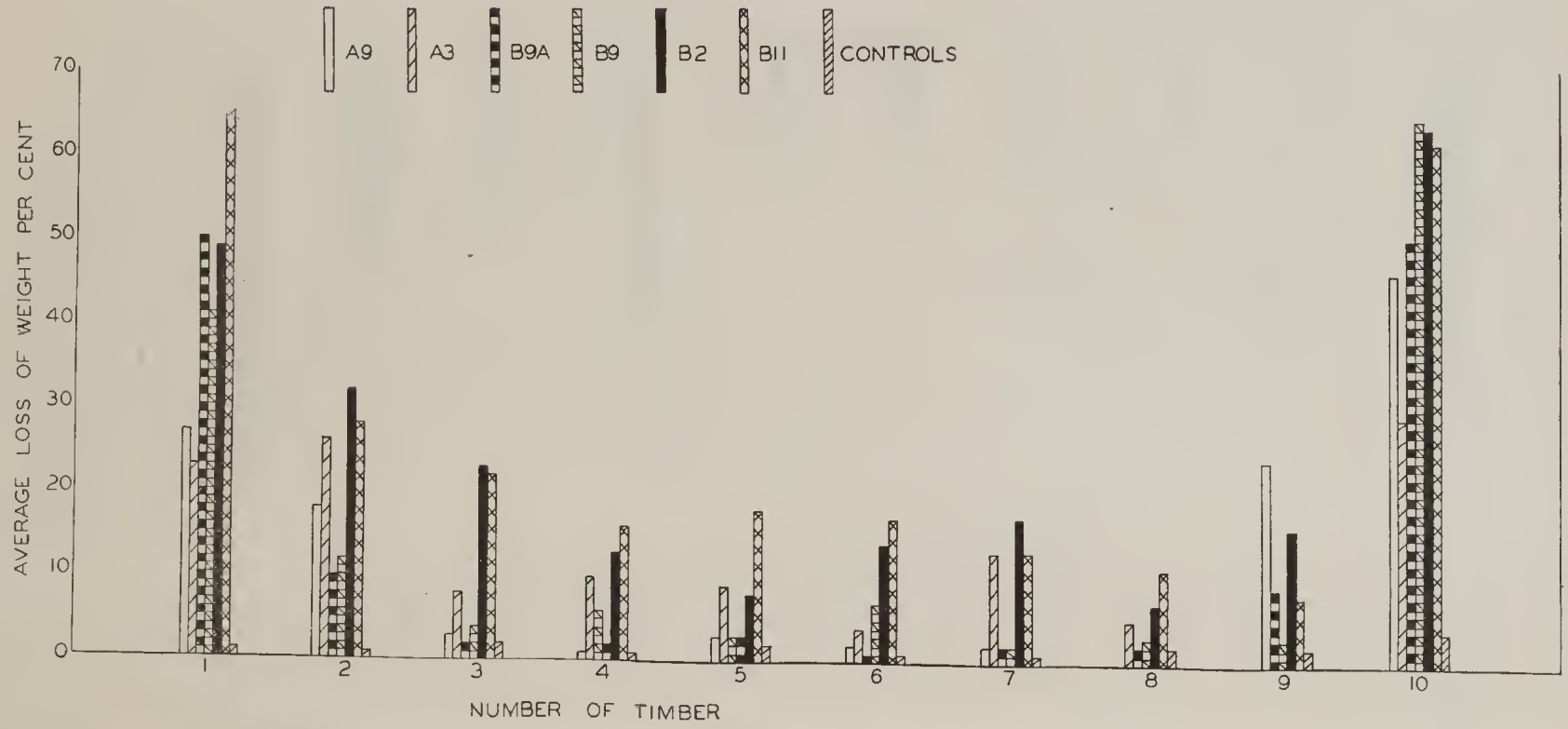
Key for Graphs

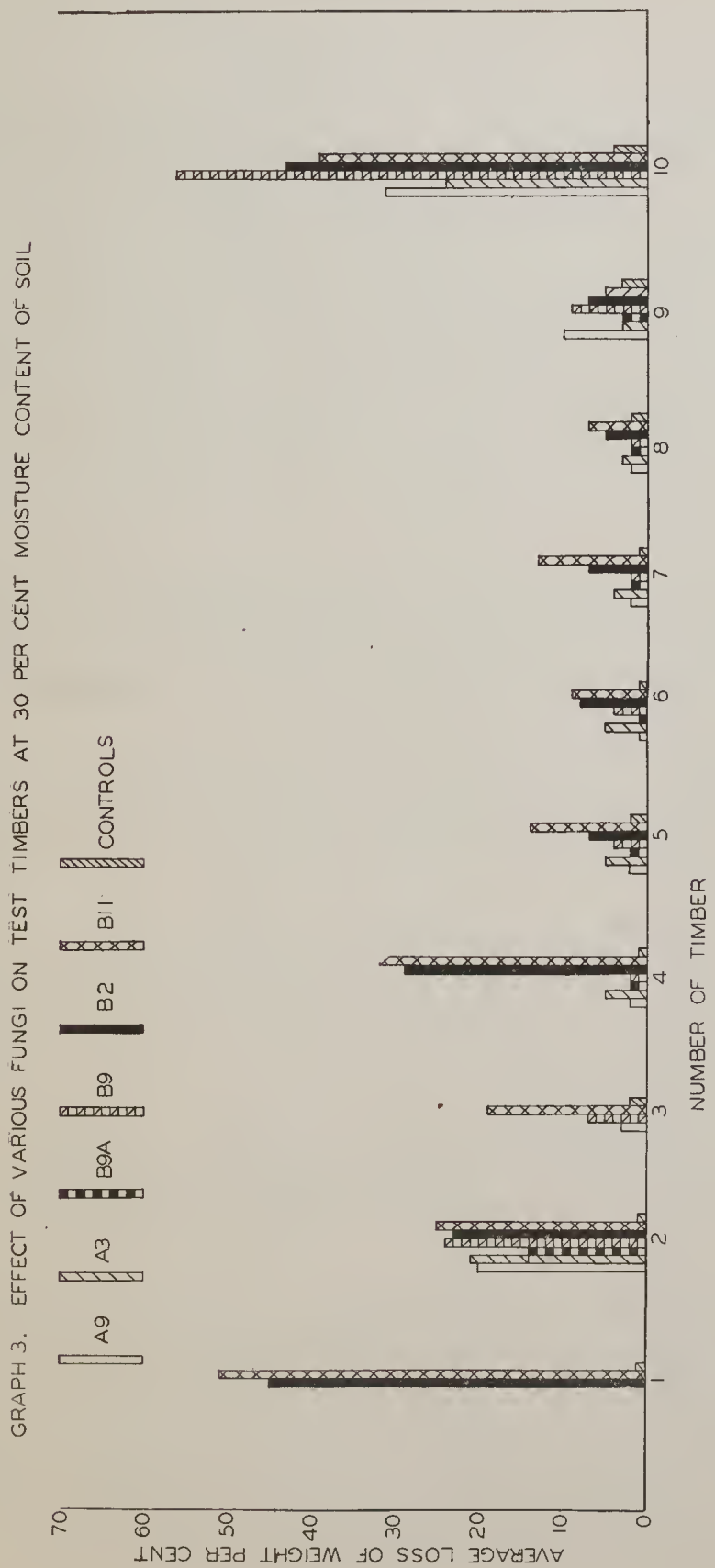
The test timbers are numbered as follows:—

1. *Eucalyptus regnans*—Mountain ash.
2. *E. obliqua*—Messmate.
3. *E. capitellata*—Brown stringy bark.
4. *E. saligna*—Sydney blue gum.
5. *E. pilularis*—Blackbutt
6. *E. maculata*—Spotted gum.
7. *E. rostrata*—River red gum
8. *E. microcorys*—Tallow-wood.
9. *Callitris glauca*—Cypress pine.
10. *Pseudotsuga taxifolia*—Oregon.


GRAPH 1. EFFECT: CONIOPHORA CEREBELLA ON TEST TIMBERS AT
□ 25 PER CENT MOISTURE CONTENT OF SOIL
■ 30 PER CENT MOISTURE CONTENT OF SOIL
AVERAGE LOSS OF WEIGHT PER CENT
0
10
20
30
40
50
60
70
1
2
3
4
5
6
7
8
9
10
NUMBER OF TIMBER.

GRAPH 2. EFFECT OF VARIOUS FUNGI ON TEST TIMBERS AT 25 PER CENT MOISTURE CONTENT OF SOIL.




GRAPH 3. EFFECT OF VARIOUS FUNGI ON TEST TIMBERS AT 30 PER CENT MOISTURE CONTENT OF SOIL
A9
A3
B9A
B9
B2
B11
CONTROLS
AVERAGE LOSS OF WEIGHT PER CENT
0
10
20
30
40
50
60
70
1
2
3
4
5
6
7
8
9
10
NUMBER OF TIMBER

Discussion of Results

Blackbutt, spotted gum, river red gum, and tallow-wood were by far the most resistant timbers tested, and they exhibited very much the same behaviour towards each of the fungi used. The statistical analysis showed that the differences in loss of weight due to decay were not significant and did not allow of comparison between these timbers. *Coniophora cerebella* and the unknown fungus D2 caused the greatest loss in weight, but even with these virulent wood-destroyers decay was not really severe. *Poria xantha, Polyporus zonalis,* and the unknown B9A did not give rise to significant loss of weight in any of these timbers, whilst *Trametes* sp. (A1 and D6) and the unknown A3 caused slight decay. The decay due to *Trametes serialis* and *Polysticus versicolor* was negligible except in the case of spotted gum, where attack was noticeable but not severe. *Merulius pinastri* caused an average of 8 per cent. loss in weight in river red gum, but practically none in tallow-wood. Its effect on blackbutt and spotted gum is not known, as inoculations of the fungus against this timber were not successful.

Mountain ash proved to be the least resistant of all the Australian hardwood timbers tested. It was attacked very readily by each fungus to which it was exposed, whether it were a hardwood or softwood destroyer. *P. xantha* and *T. serialis* decayed this timber to a considerable extent, and after six months exposure to attack by *C. cerebella* and the unknown B9A, the blocks could be crumbled easily in the hand.

Messmate was not attacked quite as readily as mountain ash, but did not prove to be a resistant timber. The softwood rotters, *P. xantha* and *T. serialis,* and the unknown brown rot forms (A3 and B9A) were able to cause appreciable brown rot in this timber, whilst attack by *C. cerebella* and *Trametes* sp. D6 was even more severe.

Brown stringy bark was more resistant than the two previous timbers to attack by *P. xantha* and *T. serialis,* but was definitely decayed by *Trametes* sp. (A1 and D6), *C. cerebella, P. zonalis,* and *M. pinastri.* Brown stringy bark was one of the few hardwood timbers with which the inoculation of *M. pinastri* was successful, and it proved very susceptible to attack by this fungus, 40 per cent. loss of weight being caused in the one series and 23 per cent. in the other.

Sydney blue gum was resistant to attack by *P. xantha* and *P. zonalis* and the unknown B9A, and only showed very little decay with *T. serialis* and *Trametes* sp. (A1). However, in the series with the higher moisture content of the soil, it was no more resistant to decay by *C. cerebella* than was messmate.

The only Australian softwood timber to be tested was cypress pine (*Callitris glauca*). For reasons that are discussed later, the results with this timber were very variable. With 25 per cent. moisture content of the soil, considerable rot was caused in most blocks of cypress pine by *P. xantha* (A9), by *Trametes* sp. (D6, but not A1), by *M. pinastri,* by *C. cerebella* (B2), but not by the virulent strain B11, and the most severe rot by the potent rotter D2. With 30 per cent. moisture content of the soil, however, D2 caused practically no rot at all, and the two isolations of *C. cerebella* only slight rot. Most rot was caused in this series by *P. xantha* A8, *Trametes* sp. (D6), and *M. pinastri.*

In view of the fact that oregon was used formerly almost exclusively in the mine, tests were carried out with this timber for comparison with the Australian hardwoods. Extreme decay resulted in every case, with hardwood and softwood rotter alike, except with *P. zonalis* where rot was significant but not high. Oregon proved to be less resistant than mountain ash, the least resistant of all the Australian timbers tested.

The classification of pole timbers according to their durability as set out by Cummins and Dadswell has already been mentioned. Although used for very different purposes, and under different conditions from mine timbers, pole timbers are subjected to conditions favourable for decay at the ground line, and a durable pole timber, just as a durable mine timber, must be resistant to decay in contact with the ground. Cummins and Dadswell placed tallow-wood and river red gum in the "durable" class, but spotted gum and blackbutt, together with messmate, were classified as "less durable." It is interesting to note that in the experiments described above, both spotted gum and blackbutt proved to be quite as resistant to attack by wood-destroying fungi as tallow-wood and red gum. Messmate behaved according to expectations from this classification, and proved considerably less resistant to attack than the above-menioned timbers. The results with messmate are not in agreement with those of Findlay (15), who included it when testing the natural resistance to decay of some Empire timbers. His figures for the decay of messmate were remarkably low compared with the Australian figures. When attacked by *Coniophora cerebella,* the loss of weight after a period of eight months was 6·5 per cent. in Findlay's experiment. In contrast to this, reference to Table 2 shows that messmate lost 28 per cent. of its weight when exposed to attack by *C. cerebella* for six months with the soil method. Findlay was using the standard Kolle flask method, in which the unautoclaved blocks are placed directly on the mycelial mat, but the difference in experimental method cannot be responsible for such a remarkable difference in the loss of weight per cent. In a test mentioned earlier, in which unautoclaved blocks of messmate were placed directly on the mycelial mat of *C. cerebella,* in a comparable way to the Kolle flask test, the loss of weight was 32 per cent., a little higher even than that achieved in the soil method experiment.

Findlay considered tallow-wood a resistant timber. He obtained slight loss of weight, but regarded this as due to loss of extractives and not to decay. In the experiments described in the present paper, there was invariably some loss of weight in the controls, and this was considered to be due to loss of water soluble extractives. It can be noted that the figures for the loss of weight in the tallow-wood controls were very slightly higher than those in other hardwoods.

Mountain ash, which proved the least resistant of the hardwood timbers tested, was not included by Cummins and Dadswell in any of their durability classes. It is not regarded as a suitable pole timber, and is generally known to be very susceptible to decay. Dadswell (12) pointed out that mountain ash is not suitable for use in contact with the ground, and the experiments with the exposure of this timber to the mine fungi confirm this statement.

Cypress pine was classed as "very durable" in the ground. Cummins and Dadswell (13) have shown that its durability is due largely to a volatile acid, for which the name callitric acid was proposed. It was doubtful at

the outset, therefore, whether the type of test used here, with its prolonged heating in the oven and autoclave would prove suitable for such a timber. A certain amount of the volatile acid was bound to be lost during heating, and the resistance to decay thus diminished. As was expected, the results were variable, some blocks proving quite resistant, while others were strongly attacked by the same fungus. The average of the loss in weight of the eight blocks seldom gave a true picture of the results. In many cases, three blocks in one jar lost little weight, while the fourth was decayed considerably: (Larger jars were used in this experiment and four blocks were placed in each jar.) The variable results were no doubt due to the unequal loss of the volatile acid and did not give a reliable indication of the real durability of this timber.

Summary

Chief among the wood-destroying fungi isolated from decayed mine timber or from fruiting bodies found in an Australian zinc mine were *Coniophora cerebella* Pers., *Polyporus zonalis* Berk., *Trametes serialis* Fr., *Poria xantha* Lind non Fr., and *Merulius pinastri* Fr. Others were isolated but not identified. *C. cerebella* and an unidentified isolation, D2, were the most potent of the wood-destroying fungi.

Inoculation experiments, using soil as a medium, were carried out to test the comparative resistance of a number of Australian timbers to decay by these fungi. Percentage loss in weight, based on the oven-dry weight, was used as a criterion of the amount of decay.

Two series of experiments were carried out for each timber. In the first series, the moisture content of the soil was 25 per cent., in the second 30 per cent. The lower percentage of moisture gave better conditions for decay in the majority of cases, but there were exceptions.

Blackbutt (*Eucalyptus pilularis*), spotted gum (*E. maculata*), river red gum (*E. rostrata*), and tallow-wood (*E. microcorys*) were outstanding in their resistance to fungal attack, and although decayed to some extent by *Coniophora cerebella*, the attack was not nearly as severe as in the case of the poorer timbers.

Mountain ash (*E. regnans*) was decayed very readily by every fungus tested. Messmate (*E. obliqua*) was not attacked quite as readily, but did not prove to be a resistant timber.

Brown stringy bark (*E. capitellata*) and Sydney blue gum (*E. saligna*) were very susceptible to attack by the potent wood-destroyer *C. cerebella*, but were considerably more resistant than mountain ash and messmate to the other less virulent fungi.

Results with cypress pine (*Callitris glauca*) were variable, probably due to unequal loss of the volatile acid to which it owes its durability.

The important softwood oregon (*Pseudotsuga taxifolia*) was decayed even more readily than mountain ash.

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Appendix

Cultural Characteristics of the Mine Fungi.

Coniophora cerebella Pers. (B2 and B11) are two isolations of *C. cerebella* resembling the type described by Cartwright and Findlay (8) as the "Idaweiche" variety. Growth commences as long white tufts from the inoculum and the colour develops quickly, passing from *straw yellow* through various shades of brown. The whorled clamp connections characteristic of *C. cerebella* can be seen on about the fourth day, just behind the tips of the young aerial hyphae. They are not seen in old cultures. Hyphae are straight and broad, usually about 4μ in diameter, but they may reach 10μ. Strand formation is rapid, but whereas the strands on malt agar usually remain light in colour, in cultures on wood blocks they become very dark and resemble closely those formed in nature. A tough velvety tubercular hymenial layer, from *Dresden brown*, *raw umber* to *Saccardo's umber* forms very frequently in older cultures, particularly in those on wood blocks, with the production of oval to almost globose brown basidiospores. In B2, these measure 6 × 4–7μ with an average of 7·5 × 5μ.

Merulius pinastri Fr. (M16).—Pure cultures of this fungus were obtained from the fruiting bodies, but never from rotting wood. The aerial mycelium on malt agar is at first thick, white, and fluffy, but as growth proceeds the mycelium in the centre turns *Pinard yellow* to *Empire yellow* and then various shades of brown, from *amber brown* to *Sudan brown*, *Argus brown*, or *cinnamon brown*. It always remains very soft and fluffy and never becomes tough. Hyphae are from 1·5 to 4μ in width and do not bear clamp connections. The mycelium acquires a powdery appearance due to the formation of numerous secondary spores, similar in size and shape to the basidiospores, but borne terminally or in an intercalary fashion on the mycelium. They are oval and brown in colour, measuring from 3·5–6 × 2–5μ with an average of 4·2 × 3·2μ. Fine silky strands cling to the wall of the test tube or in wood block cultures pass from the blocks out on to the neighbouring soil and up the wall of the jar. Growth in culture is extremely slow, a colony only reaching a diameter of approximately 2 cm. in fourteen days.

Polyporus zonalis Berk. (Syn: *Polyporus rugulosus*).—The cultural characteristics of this white rot fungus have been described by Davidson, Campbell and Vaughan (14). Growth on malt agar is at first very long, white and silky. The aerial hyphae are straight and broad, up to 4μ in diameter, and do not bear clamp connections. Also typical are the mosaic-like sheets formed by the union of short hyphae. The aerial mycelium soon flattens, becoming *pinkish-buff* in colour and forming a dense flannel-like mat. Small velvety *pale orange yellow* lumps appear here and there and show on microscopic examination the encrusted cystidia so common in the hymenium of the fruiting body. Basidiospores have not been seen in culture.

Trametes serialis Fr. (B9).—The cultural characteristics of this fungus have been described in detail by Cartwright and Findlay (8) and by Snell (19). The Australian isolations agree very closely both as to macroscopic and microscopic characters. Growth on malt agar is at first somewhat sodden and appressed, but soon becomes more cotton-woolly. The mycelium is white, but later shows tinges of *salmon colour* and *light salmon orange* and small patches of *bistre brown*, particularly at the top of the slope where growth is more luxurious than in the lower portion and tends to plug the tube. Numerous single clamp connections are seen on the aerial and submerged mycelium. Chlamydospores are present and are usually oval and intercalary, but are occasionally rounded and terminal. They range from 8·5–21·5 × 6·5–11·5μ, with an average of 12 × 8μ. Fine foliose fructifications develop, sometimes after a week or ten days, particularly on the inoculum, and produce typical basidia and basidiospores. The basidiospores are oval and hyaline, and range from 4–6 × 2μ3μ.

Trametes sp. (A1 and D6).—It has already been mentioned in the course of the paper that many cultures obtained both from fruiting bodies and from decayed wood resembled those of *Polyporus fumosus*, as described by Cartwright (7), although the fruiting bodies were thought to belong to *Trametes serialis*. Typical of these cultures, which are referred to as *Trametes* sp. throughout the paper, are the isolations A1 and D6, A1 was obtained from hardwood showing brown rot, D6 from brown rot in oregon. Growth on malt agar is at first white, soft, and downy, but soon becomes tufted and very powdery and light-buff in colour. The powdery appearance is due to the formation of very numerous chlamydospores on the aerial mycelium. Many single clamp connections are present and they sometimes give rise to branches. Hyphae are mostly fine, 1–2μ in diameter, but may reach a width of 5 or 6μ. Rhomboidal crystals are common.

The chlamydospores are mostly terminal and often borne in clusters, but are sometimes intercalary. In cultures of A1, the chlamydospores range from 5–9μ in diameter, with an average of 7·5μ. In D6, they range from 5–10 × 4–7μ, with an average of 7·3 × 5·4μ. Chlamydospores are also very numerous in the tissue of the fructification. Small velvety pads of fructification are formed in culture of both A1 and D6 They usually turn yellow to brown in colour when formed on malt agar, but when produced on wood blocks are often large and cushion-like, and remain white to cream for some months before turning *bistre brown*. They produce basidia and hyaline basidiospores in a hymenium-like layer. In A1, the basidiospores are 4–5 × 2·5–4μ, with an average size of 5–2·5μ. Findlay and Cartwright (9) describe the cultures of *P. fumosus* as being soft, thin, and farinaceous to powdery, at first white then pale *cartridge buff*, with numerous secondary spores averaging 8–10μ, borne in tufts. Cartwright (7) gives further details of the culture of *P. fumosus*, mentioning the above features, and also the presence of rhomboidal crystals and the formation of hymenial surfaces with normal basidia and basidiospores and hyphae measuring 1–5μ in diameter, though mostly 1·5–2μ. It can be seen that there are very strong resemblances between the cultural characters of *Polyporus fumosus* and those of A1 and D6. However, as no cultures of *P. fumosus* are available for comparison, it is thought advisable to refer cultures of A1 and D6 to *Trametes* sp.

Poria xantha Lind. non Fr. (A8 and A9).—These are two isolations of *Poria xantha* from brown rot in oregon. The cultures agree very closely with the description given for this fungus by Cartwright and Findlay (8). A very pronounced sweet lemon-like odour characterizes the cultures, and is noticeable by the sixth or seventh day. This confirms the observations of Badcock (1) who reports that *P. xantha* has an odour resembling liminene, or almost lemon. This odour is also a feature of the fructification.

Growth on malt agar is fine and cobwebby, and never luxurious. Fine white or yellow strands pass out from the inoculum over the surface of the agar. Hyphae are fine, and single clamp connections are numerous in aerial and submerged mycelium. A pored hymenial layer soon forms at the top of the slope and gradually covers the greater part of the surface. In cultures of A8 it is chalky-white to cream, whereas in cultures of A9 it is *picric yellow* to *pale lemon yellow* in colour. Typical small allantoid basidiospores are formed abundantly on the hymenium. In A8 they range from 3–7 × 1·5–2·5μ in size, with an average of 4·7–2μ. Measurements for basidiospores in A9 are almost identical, with a range of 3–7 × 1·2–2·5μ and an average of 4·7 × 2μ.

Unknown A3 was isolated in culture from decayed messmate with light-brown stringy to spongy rot. The culture on malt agar is thick, flat, white, and felted, and even old cultures rarely show any change of colour except for a slight yellowing. No secondary spores are seen in culture, either on malt agar or on wood blocks. Single clamp connections are numerous on the submerged mycelium.

Unknown B9A is an unidentified basidiomycete isolated from oregon with brown stringy rot. Early growth in culture on malt agar is thick, white, and fluffy, but the mycelial mat becomes felted with age. It remains pure white even in old cultures. Single clamp connections occur frequently, and numerous rounded, oval, or pear shaped chlamydospores are present, ranging from 8–16 × 6–12μ, with an average size of 11 × 8μ. Rather spiky coral-like white abortive fructifications form around the inoculum and produce small oval hyaline basidiospores. The measurements of these are from 4–6 × 2–3μ, with an average of 5 × 2·5μ.

Unknown D2 was isolated frequently from hardwood timber with a dark-brown stringy rot, but was not identified. A pure white cotton-woolly mat forms rapidly on malt agar and soon blocks the whole tube. There is little alteration in appearance as the culture ages, except for a change to *cream colour* or *light-buff*. The hyphae are extremely broad, usually from 6–20μ in width, and show short blunt branches. No clamp connections are formed. Round to oval chlamydospores are very common, and range from 9–14 × 5–11μ, with an average size of 11·5 × 7·8μ. When crushed the culture has a pronounced mushroom odour.

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